Calendar No. 1041

99TH CONGRESS
2d Session

SENATE

REPORT
99-514

WITHDRAWING PUBLIC LANDS FOR MILITARY PURPOSES

OCTOBER 1 (legislative day, SEPTEMBER 24), 1986.—Ordered to be printed

Mr. MCCLURE, from the Committee on Energy and Natural Resources, submitted the following

REPORT

together with

MINORITY VIEWS

[To accompany S. 2412]

The Committee on Energy and Natural Resources, to which was referred the bill (S. 2412) to withdraw and reserve certain public lands, having considered the same, reports favorably thereon with amendments to the text and recommends that the bill, as amended, do pass.

The amendments are as follows:

1. On page 1, line 5 strike "laws—" and insert: "laws, except as otherwise provided for in this Act—".

2. On page 10, line 10 delete "determines." and insert in lieu thereof: "determines: *Provided,* That the Secretary shall allow public access to and use of the lands withdrawn under section 1(e) and 1(f) for purposes of recreation, hunting, fishing, and trapping to the fullest extent compatible with the essential military requirements relating to such lands as determined by the Secretary.".

3. On page 17, after line 5, add a new section 11 as follows:

> SEC. 11. Nothing in this Act shall be construed to prohibit the Secretary of the Interior from exercising his authority under Public Law 91-581 (30 U.S.C. 1002), to issue leases for the development and utilization of geothermal steam and associated geothermal resources on Federal Lands in the China Lake Naval Weapons Center as described in sec. 1(h) of this Act.

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4. On page 17, after line 5 add a new section and number accordingly:

SEC. 12. Nothing in this Act shall affect the geothermal exploration and development authorities granted to the Secretary of the Navy by section 6(c)(1) of the Act of July 12, 1982 (10 U.S.C. 2689), except that the Secretary of the Navy is required to obtain the concurrence of the Secretary of the Interior prior to taking action under that section with regard to Federal lands of the Naval Weapons Center as described in section 1.(h) of this Act.

5. On page 17, after line 5 add the following new sections and number accordingly:

SEC. 13. (a) As soon as possible after the enactment of this Act and at least every 5 years thereafter, the Secretary of the Interior (hereinafter referred to as "Secretary") is hereby authorized and directed to determine, with the concurrence of the Secretary of the military departments concerned, which public and acquired lands in the military withdrawals described in subsections (a), (b), (d), (e), (f), (g), and (h) of section 1 of this Act he considers suitable for opening to the operation of the Mining Law of 1872, the Mineral Lands Leasing Act of 1920, as amended, the Mineral Leasing Act for Acquired Lands of 1947, and the Geothermal Steam Act of 1970. He shall publish a notice in the Federal Register listing those lands and specifying the opening date. Provided, however, that lands contained within the Desert National Wildlife Range in Nevada shall not be determined to be suitable for operation of the aforementioned mining or mineral leasing laws.

(b) On the day specified by the Secretary in the notice published in the Federal Register, the land shall automatically be open to the operation of the laws specified in subsection (a) of this section without the necessity for further action by either the Secretary or the Congress.

(c) No deposit of minerals or materials of the types identied by section 3 of the Act of July 23, 1955 (69 Stat. 367), whether or not included in the term "common varieties" in that Act, shall be subject to location under the Mining Law of 1872 on lands covered by this Act.

(d) All minerals subject to location under the Mining Law of 1872 are hereafter referred to in this Act as "locatable minerals".

SEC. 14. The Secretary, with the advice and concurrence of the Secretary of the concerned military department or departments, as appropriate, shall promulgate such regulations, pursuant to this Act, as he deems necessary to assure safe, uninterrupted, and unimpeded use of the lands for military purposes. The regulations shall also contain guidelines to assist mining claimants in determining how much of the surface may be used for purposes incident to mining.

SEC. 15. In the event of a national emergency or for purposes of national defense or security, the Secretary, at the request of the Secretary of the concerned military installation, shall close any lands that have been opened to mining or to mineral or geothermal leasing in accordance with this Act.

SEC. 16. (a) Except as otherwise provided in this Act, mining claims located pursuant to this Act shall be subject to the provisions of the mining laws. In the event of a conflict between those laws and this Act, this Act shall prevail.

(b) All mining claims located under the terms of this Act shall be subject to the provisions of the Federal Land Policy and Management Act of 1976 (90 Stat. 2743).

SEC. 17. (a) Patents issued pursuant to this Act for locatable minerals shall convey title to locatable minerals only, together with the right to use so much of the surface as may be necessary for purposes incident to mining under the guidelines for such use established by the Secretary by regulation.

(b) All such patents shall contain a reservation to the United States of the surface of all lands patented and of all non-locatable minerals on those lands.

SEC. 18. The United States and all departments or agencies thereof shall be held harmless and shall not be liable for any injuries or damages to persons or property suffered in the course of any mining or mineral or geothermal leasing activity conducted pursuant to this Act.

PURPOSE OF THE MEASURE

S. 2412, as reported, would withdraw approximately 7.5 million acres of public lands for use by the Department of Defense for military purposes.

BACKGROUND AND NEED

In the 98th Congress, the Administration transmitted a number of bills that would have withdrawn approximately 7.5 million acres of certain public lands for use by the Department of Defense for military purposes. The Public Lands, Reserved Water and Resource Conservation Subcommittee held a hearing on the bills in August of 1984. Neither the Senate nor the House moved the bills passed the hearing stage and they died at the end of the 98th Congress.

The lands involved with (with the exception of 90,000 acres at Nellis AFB) all withdrawn for military purposes at one time. However, all public laws, Executive Orders, and public land orders creating their withdrawal have expired. Military use of the areas involved is continuing, but without the required statutory approval by Congress.

Congressional concern over executive withdrawals of public lands for military purposes led to enactment of the Act of February 28, 1958 (72 Stat. 27) frequently referred to as the "Engle Act". The basic purposes of the Act were set out by the House Committee on Interior and Insular Affairs as follows:

H.R. 5538 deals with defense agency acquisition and use of the public lands and associated resources of the United States for defense purposes. The broad purpose and objective of the bill is to return from the executive branch to the Congress—to the extent that such lands are involved—the responsibility imposed by the Constitution on the Congress for their management.

H.R. 5538, in addition, would set out clear-cut statutory requirements for the utilization and disposition of certain of the resources found within existing and future military installations and facilities so as to assure highest and best management, conservation, utilization and development thereof on a continuing basis (H.R. Rep. No. 215, 85th Congress, 1st Session, 1957).

The areas proposed for withdrawal are:

Name	State	Acres
Bravo–20 Bombing Range	Nevada	21,576
Nellis Air Force Range	do	2,945,000
Luke Air Force Range	Arizona	2,664,423
McGregor Range	New Mexico	608,384
Ft. Greely Maneuver Area	Alaska	571,995
Ft. Wainwright Maneuver Area	do	247,951
Chocolate Mountain Aerial Gunnery Range	California	132,928
China Lake Naval Weapon Center	do	1,100,000

Legislation is required for the proposed withdrawals under the requirements of the Engle Act which states in part that withdrawal of more than 5,000 acres of public land for any one project or facility of DOD be done only by Act of Congress. All public laws, public land orders and Executive Orders creating withdrawal for the existing units have expired. S. 2412 combines each of these eight areas in one bill.

Current overlapping uses of the Nellis Air Force Range include a 826,000 acre portion of the Desert National Wildlife Range and the Department of Energy, (AEC) for the Nevada Test Site, the Tonopah Test Range and other underground explosion test sites. A Memo of Understanding between DOI, the Air Force, and DOD provides guidelines, responsibilities and joint use of the refuge.

The Cabeza Prieta National Wildlife Refuge (860,000 acres) overlaps the Luke Air Force Range. A 1975 Memo of Understanding between DOI, the Air Force and Navy provides guidelines, responsibilities and joint use of the refuge.

LEGISLATIVE HISTORY

S. 2412 was introduced on May 6, 1986 by Senator McClure, Senator Wallop, Senator Goldwater, Senator Hecht and Senator Laxalt. The Subcommittee on Public Lands, Reserved Water and Resource Conservation held a hearing on the bill on July 17, 1986.

At a business meeting on September 24, 1986, the Senate Committee on Energy and Natural Resources ordered S. 2412, as amended, favorably reported.

COMMITTEE RECOMMENDATIONS AND TABULATION OF VOTES

The Senate Committee on Energy and Natural Resources, in open business session on September 24, 1986, by majority vote of a quorum present recommends that the Senate pass S. 2412, if amended, as described herein.

The rollcall vote on reporting the measure was 15 yeas, 1 nay as follows:

YEAS	NAYS
Mr. McClure	Mr. Metzenbaum*
Mr. Hatfield*	
Mr. Weicker*	PRESENT
Mr. Domenici	Mr. Bumpers
Mr. Wallop	
Mr. Warner	
Mr. Murkowski	
Mr. Nickles	
Mr. Hecht	
Mr. Evans	
Mr. Johnston	
Mr. Ford	
Mr. Melcher*	
Mr. Bingaman*	
Mr. Rockefeller	

*Indicates voted by proxy.

COMMITTEE AMENDMENTS

Amendment number 1 is a conforming amendment that recognizes that all of the areas subject to withdrawal with the exception of the Luke Air Force Range in Arizona are open to some degree of entry under the Mining Law of 1872, the Mineral Lands Leasing Act of 1920, as amended, the Mineral Leasing Act for Acquired Lands of 1947, or the Geothermal Steam Act of 1970, as appropriate.

Amendment number 2—the intent of this language is to provide specific guidance to the Secretary to ensure that the military follows a consistent approach in providing access to the two withdrawals in Alaska. The Committee finds that absent such guidance, base commanders frequently vary their policies on access issues. Consistency and equity are required to protect a number of long established public uses of the areas involved.

Amendment number 3—between 1981 and 1985 through a competitive bidding process under the Geothermal Steam Act, the City of Los Angeles Department of Water and Power and the California Energy Company each obtained several leases from the Bureau of Land Management, under the amended Public Land Order 431, to develop geothermal energy on lands known as the Coso Geothermal Area within the China Lake Naval Weapons Center. Drilling operations to assess the geothermal resource have been underway.

The Committee amendments states that nothing in this Act is to prohibit the Secretary from exercising his authority to issue geothermal leases under the Geothermal Leasing Act.

The fourth amendment would authorize the Navy to continue geothermal exploration and development of their facilities at the Naval Weapon Center with the concurrence of the Secretary of the Interior.

The last of the Committee's amendments provides authority to the Secretary of the Interior, with the *concurrence* of the Secretary of the military departments concerned, to permit mining activities under the Mining Law of 1872, leasing activities under the Mineral Lands Leasing Act of 1920, the Mineral Leasing Act for Acquired Lands of 1947 and the Geothermal Steam Act of 1970 on public land and acquired lands as appropriate in military withdrawals contained in S. 2412. The only exceptions to this authority are lands to be withdrawn for military purposes at the "Luke Air Force Range" in Maricopa, Pima and Yuma Counties, Arizona, and withdrawn lands within the Desert National Wildlife Range in Nevada.

Before mining and mineral leasing activities can take place on military withdrawn lands, a determination has to be made as to which lands within such withdrawals are suitable for such activities. This determination is to be made as soon as possible after enactment of S. 2412 and at least every 5 years thereafter.

Once such determination is made, the Secretary of the Interior publishes a listing of those lands available for mining and mineral leasing activities in the Federal Register and indicates the date such lands become available.

The amendment specifies that "common varieties" of minerals (i.e. sand, gravel, stone, etc.) are not subject to location under this bill or the Mining Law of 1872. Minerals subject to location under the Mining Law of 1872 are referred to as "locatable minerals" (i.e. gold, lead, copper, silver, zinc, etc.).

The amendment further provides that the Secretary of the Interior and the Secretary of the concerned military department(s) concur in the development of regulations deemed necessary to assure safe, uninterrupted, and unimpeded use of the lands for military purposes including the development of guidelines for assisting mining claimants in determining how much of the surface may be used for purposes incident to mining.

The amendment provides for closure of such lands opened to mining and mineral leasing when the Secretary of the concerned military installation request closure from the Secretary of the Interior on the basis of a national emergency or for purposes of national defense or security.

Mining claims located on military lands must comply with the provisions of the Federal Land Policy and Management Act.

This amendment authorizes mining claim patents to be issud to the locatable monerals and not to the surface overlying such minerals.

Finally, this amendment holds the United States harmless for any injuries or damage to persons or property suffered in the course of conducting any mining or mineral related activities authorized by the bill.

Road closing

State Road 506 provides a vital link between communities on the east side of the McGregor Range in the State of New Mexico and the county seat of Alamogordo. Frequent closings of State Road 506 during missile firings, although necessary for the safety of the public, create delays, and inconveniences for the local citizenry. The Committee believes that the closures of State Road 506 should be kept to a minimum, and in no case should the road be closed for more than four days in any given week.

COST AND BUDGETARY CONSIDERATIONS

The following estimate of the cost of this measure has been provided by the Congressional Budget Office:

U.S. CONGRESS,
CONGRESSIONAL BUDGET OFFICE,
Washington, DC, September 29, 1986.

Hon. JAMES A. MCCLURE,
Chairman, Committee on Energy and Natural Resources,
U.S. Senate, Washington, DC.

DEAR MR. CHAIRMAN: The Congressional Budget Office has reviewed S. 2412, a bill to withdraw and reserve certain public lands, as ordered reported by the Senate Committee on Energy and Natural Resources, September 24, 1986. We estimate that enactment of this bill will result in additional costs to the federal government totaling approximately $5 million over the 1987–1991 period. Additional costs could result later if the military decontaminates land before relinquishing it to the Department of the Interior (DOI), but it is not possible to estimate the magnitude or the timing of these costs at this time.

S. 2412 would withdraw approximately 8.3 million acres of federally owned land in Nevada, Arizona, New Mexico, Alaska, and California and reserve them for use by the Army, Air Force and the Navy. The lands, which are currently being used for the military purposes specified in the bill and administered by DOI, would remain available for renewable periods of 25 years for various defense-related purposes, including armament testing, aerial gunnery and bombing training. DOI would be required to continue to manage the withdrawal lands, to publish maps and legal descriptions on the lands, and to develop management plans for all withdrawn lands within five years of the bill's passage. DOI would also be required to identify lands within certain of the withdrawal areas suitable for certain mineral and geothermal activities, to promulgate regulations for the use of these lands for mining development, and to continue to allow geothermal leasing and development at the China Lake Weapons Center in California.

Based on information from DOI and the military department involved, CBO estimates that preparation of management plans as required by S. 2412 will result in additional costs totaling approximately $5 million over the 1987–1991 period. Additional costs would also be incurred if the military decontaminates the lands before relinquishing them, but based on available information, we

cannot determine whether decontamination would be feasible or what the cost might be.

Other provisions of the bill are not expected to result in significant additional costs to the federal government.

Enactment of this bill would not affect the budgets of state or local governments.

If you wish further details on this estimate, we will be pleased to provide them.

With best wishes,

Sincerely,

EDWARD GRAMLICH
(For Rudolph G. Penner, Director).

REGULATORY IMPACT EVALUATION

In compliance with paragraph 11(b) of Rule XXVI of the Standing Rules of the Senate, the Committee makes the following evaluation of the regulatory impact which would be incurred in carrying out S. 2412. The bill is not a regulatory measure in the sense of imposing Government-established standards or significant economic responsibilities on private individuals and businesses.

No personal information would be collected in administering the program. Therefore, there would be no impact on personal privacy.

Little, if any, additional paperwork would result from the enactment of S. 2412, as reported.

EXECUTIVE COMMUNICATIONS

On September 16, 1986, the Committee on Energy and Natural Resources requested legislative reports from the Departments of the Interior, Defense and the Office of Management and Budget setting forth executive views on S. 2412. These reports had not been received at the time the report on S. 2412 was filed. When the reports become available, the chairman will request that they be printed in the Congressional Record for the advice of the Senate.

MINORITY VIEWS OF SENATOR METZENBAUM

This bill withdraws more than 8 million acres of land in 5 States for military training, weapons testing, aerial and ground manuevering and related support activities. In two areas, this bill will withdraw lands contained within units of our National Wildlife Refuge System.

Although the military currently uses many of the lands included in the proposed withdrawals, it has lacked the legal authority to do so for nearly 10 years in most cases and for nearly 25 years in at least one instance (the Bravo 20 range in Nevada). In order to correct this unlawful use of land by the military, the committee bill reserves the lands for military use for a period of 25 years. Clearly, there is a need for Congress to act and resolve the status of these lands. However, resolving this particular issue cannot and should not be the sole objective of this legislation.

It is extremely unsettling that the military continued to make use of public lands after its authority to do so had lapsed. It raises disconcerting questions about the military's willingness to obey the terms and conditions of future withdrawals, and its respect for the public's rights to its own lands.

This argues strongly that any action taken by Congress to resolve the status of these lands must provide comprehensive protection against abusive practices which would destroy an area's long term capability to provide multiple benefits, and should explicitly delineate Congress' expectations with respect to the military's rights and responsibilities during the period of the withdrawal. Otherwise, it cannot be certain that these BLM and refuge lands will be treated in a fashion which will facilitate their return to public uses in the future.

The bill which was adopted by the committee does not provide this needed protection. It fails to provide for decontamination of the withdrawal areas. It does not reinforce the requirements for comprehensive environmental impact statements on the current and projected uses of the withdrawn lands and adjacent areas. There is inadequate protection for the portions of the two national wildlife refuges which are included in the withdrawals. Finally, the length which are included in the withdrawals. Finally, the length of the withdrawals is inconsistent with the principle of frequent and recurring congressional review of the need and purpose of such withdrawals, which is established in current land management legislation.

As already noted, these withdrawals total over 8 million acres. A great deal of additional land and airspace adjacent to the withdrawal areas are also employed for military purposes. As the amount of land dedicated to military use increases, and the level of activities on these sites increase, it is critical to provide a comprehensive analysis of the continuing need for, alternatives to and the

impacts of these military operations. This is the only way to ensure that citizens and public officials will be able to identify, plan for, and mitigate adverse impacts to their environment and communities.

To date, the military's environmental assessments of withdrawal areas have not provided a comprehensive view of planned activities. They have failed to consider how each area will be used in conjunction with adjacent and related areas. This makes it difficult, if not impossible, for State agencies and the public to obtain an accurate estimate of the cumulative impacts of a withdrawal, and to fully participate in the decision process relating to withdrawals and any required mitigation planning.

The ultimate goal of any military withdrawal legislation should be the return of the lands to public use and recreation. As a result, the bill should ensure that the military will, top the greatest extent possible, maintain safe and productive conditions on the lands. Since military activities on these properties often involve the use of hazardous, toxic and explosive material, it is essential that the defense agencies conduct an ongoing decontamination effort. Otherwise, the lands may be so contaminated as to preclude their return to the public domain, and create an unacceptable danger to individuals who might enter them.

The bill as passed by the committee does not provide for any regular maintenance or decontamination program during the period of the withdrawal. Rather, a decontamination effort is only prescribed at the conclusion of the withdrawal. Moreover, the bill provides that if the cost of decontamination is deemed by the military or Interior to be too expensive, the military will retain control of the land. This approach presents the possibility that many heavily contaminated areas will never be cleaned nor returned to public use. Indeed, the provisions of this bill actually provide an incentive for the military to heavily contaminate an area in order to turn a temporary withdrawal into a de facto permanent withdrawal, in violation of the Engle Act, the Federal Land Policy Management Act [FLPMA], the refuge laws and common sense. A regular maintenance and decontamination program will ensure that the quality of the land is maintained, ensure that it will be available for public use in the future and will spread the cost of decontamination over the life of the withdrawal rather than artificially creating a prohibitively large, one time expense.

The withdrawals Approved in the committee bill include portions of two national wildlife refuges. These areas include vital wildlife habitats for endangered species and other unique plant and animal life. For this reason, they merit special protection and consideration. In the past, executive orders and memoranda of understanding have specified the purposes of these refuges and specifically limited the military activities allowed to take place on them. The bill changes the status quo and does not uphold the protections currently afforded these areas.

While there are as many as 64 laws which govern the programs and activities on wildlife refuges, the committee bill only provides for the continuance of one refuge law, the National Wildlife Refuge Administration Act. This leaves open the possibility that other laws which provide important refuge management guidance may

no longer be in effect regarding operations and uses on these areas. This could seriously jeopardize the protection and maintenance of the wildlife and other natural resources on these refuges.

Even the limited protection provided in the bill is illusory, however, for the legislation gives the military a blank check to use the refuges for any purposes it desires, even if they are inconsistent with previously negotiated agreements or refuge laws, as long as the Secretary of Defense unilaterally determines the activities are necessary for "National Defense".

This latitude is unwarranted as well as undesirable. Military testimony before this committee indicated that the refuge areas were only needed to continue the type and level of activities now occurring, such as the aerial activities on the Cabeza Prieta refuge which have little, if any, land impact, and are specified in a memorandum of understanding. The current military activities on the desert refuge are training for aerial gunnery, rocketry, electronic warfare, and tactical manuevering and air support, but only to the extent authorized in an executed agreement with the Fish and Wildlife Service.

Finally, the 25 year withdrawal period provided in the bill is contrary to the principles established in current laws governing land withdrawals, weakens the ability of Congress to maintain close oversight of these areas, and is inconsistent with sound planning principles.

In 1958, Congress enacted the Engle Act, requiring that proposed military withdrawals of 5,000 acres or more be subjected to congressional review. Similarly, FLPMA established explicit guidelines on land withdrawals by limiting executive authority to 20 years and expressly stating that extensions should normally be no longer than the original withdrawal.

The purposes of these laws are quite clear. Congress recognized the need for periodic reviews of the withdrawals, in order to determine if they are still necessary, to assess if there are significant deviations from the originally planned uses of the areas, and to evaluate the impacts of the military oerations.

The provisions of the committee bill are clearly inconsistent with these principles

The 25 year withdrawal period will almost certainly result in the military undertaking activities, development, and actions over which this committee and perhaps the Congress will have little oversight opportunity. This should not happen. The Engle Act and FLPMA expressly recognized that reasonably frequent congressional oversight is desirable, even necessary. We should not give away that important function.

Moreover, the withdrawals should not exceed a normal planning time frame. It is impossible for the military to accurately project, or for the Congress to assess, what the demand for a particular area will be over a 25 year period. Indeed, most Federal land management agencies limit their planning horizons to a 10 to 15 year time frame. That would be a more apporpriate length for the withdrawals established in the bill.

I proposed a series of amendments to address the shortcomings outlined above, but they were not adopted by the committee. I intend to pursue these issues when the bill is considered on the floor of the Senate.

HOWARD M. METZENBAUM.

CHANGES IN EXISTING LAW

In compliance with paragraph 12 of Rule XXVI of the Standing Rules of the Senate, the Committee notes that no changes in existing law are made by the bill S. 2412, as reported.

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99TH CONGRESS
2d Session

SENATE

REPORT
99-515

FUEL CELLS ENERGY UTILIZATION ACT OF 1985

OCTOBER 2 (legislative day, SEPTEMBER 24), 1986.—Ordered to be printed

Mr. MCCLURE, from the Committee on Energy and Natural Resources, submitted the following

REPORT

[To accompany S. 1687]

The Committee on Energy and Natural Resources, to which was referred the bill (S. 1687) to develop a national policy for the utilization of fuel cell technology, having considered the same, reports favorably thereon with an amendment to the text and recommends that the bill, as amended, do pass.

PURPOSE OF MEASURE

The purpose of the bill, as reported by the Committee on Energy and Natural Resources, is to develop a national policy for the utilization of fuel cell technology.

SUMMARY OF MAJOR PROVISIONS

S. 1687 as reported by the Committee on Energy and Natural Resources contains the following major provisions:

(1) Amends section 256 of the Energy Policy and Conservation Act to include industries using fuel cell technology under the term "domestic renewable energy industry" for the purpose of obtaining an assessment of its potential in international export markets.

(2) Charges the Environmental Protection Agency with the preparation of Federal guidelines for the benefit of cities and municipalities in specifying environmental and safety standards for use of fuel cell technology.

(3) Requires the Secretary of Commerce to make an assessment and report to Congress within 180 days of enactment regarding the export potential for integrated systems of fuel cells with renewable power technologies.

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Background and Need

The Congressional Research Service last year issued a report, entitled "Fuel Cells for Electric Power Production: Future Potential, Federal Role and Policy Options" (85–523 SPR). The report estimated the Federal investment in fuel cell technology over the prior 10-year period at $260 million in research and development expenditures. The report credited to congressional initiatives the Federal role in nurturing the technology to a point where prospects for full commercialization appear promising. Nevertheless, the report cited a need for an implementation-related strategy that could facilitate attainment of payoffs from the Federal role in research and development. This bill is aimed at achieving such a policy change.

The fuel cell, an electro-chemical device first constructed by Sir William Grove in 1839, had its first practical application in the Gemini V flight of August 1965, where it proved to be an efficient, reliable power generator with very high-energy density. It operates by combining hydrogen-rich gas with air and converting the chemical energy of this mixture into electricity directly without any intermediate combustion step; hence its high efficiency. A fuel cell takes in air and a liquid or gaseous hydrocarbon fuel produces direct current at high conversion efficiency rates, 40 to 60 percent, plus a low amount of waste heat and water with carbon dioxide. Heat generated is sufficient to permit cogeneration space heating, for an overall efficiency rate as high as 80 percent. A typical cell produces high direct current in a low voltage. Practical voltages are obtained by connecting many individual cells into what is referred to as a cell stack.

Besides their high efficiencies, fuel cells offer to public utilities a number of logistical advantages based on modular construction. Fuel cells are also applicable to decentralized power systems, including hybrid applications with renewable systems.

By requiring Federal agencies to specifically recognize this technology through existing information channels the Congress will be expediting the acceptance of fuel cells in the commercial market.

Legislative History

S. 1687 was introduced on September 20, 1985, by Senator Matsunaga for himself, and Senator Weicker, Senator Hollings, and Senator Murkowski. Senator Inouye was added as a cosponsor of the bill on October 29, 1985, and Senator Hecht on March 25, 1985. The bill was referred to the Committee on Energy and Natural Resources. It was sequentially referred to the Committee on Environment and Public Works for 30 calendar days for the purpose of considering the provision addressing EPA guidelines for use of fuel cell technologies. On February 24, 1986, the Subcommittee on Energy Research and Development held a legislative hearing on S. 1687.

The Committee heard testimony in support of the bill from a broad variety of witnesses representing power utilities, manufacturers and industrial users, university research programs, Los Alamos National Laboratory, and industry organizations. A number of witnesses cited the contribution fuel cell technology might be expected to make to improve the Nation's international

trade position because of its application to decentralized, hybrid power systems for overseas markets.

Committee Recommendation and Tabulation of Votes

The Committee met in open business to consider S. 1687 on September 24, 1986. The Committee, with a quorum present, recommended that the Senate pass S. 1687, if amended as described herein. The rollcall vote on the reporting of the measure was unanimous.

YEAS	NAYS
Mr. McClure	
Mr. Hatfield*	
Mr. Weicker*	
Mr. Domenici	
Mr. Wallop	
Mr. Warner	
Mr. Murkowski	
Mr. Nickles	
Mr. Hecht	
Mr. Evans	
Mr. Johnston	
Mr. Bumpers	
Mr. Ford	
Mr. Metzenbaum*	
Mr. Melcher*	
Mr. Bradley*	
Mr. Bingaman*	
Mr. Rockefeller	

*Indicates voted by Proxy.

Committee Amendment

The Committee adopted an amendment to strike section 3 "Eligibility for Exemptions under PURPA", which would include facilities utilizing fuel cell systems in the definition of "cogeneration facility" in section 210 of the Public Utilities Regulatory Policies Act (PURPA). The Committee is concerned that the broadening of the definition of "cogeneration facility" in PURPA may not be appropriate at a time when regulators, States and other affected interests are questioning the benefits to ratepayers of the PURPA program of encouraging cogeneration and small power production.

Phosphoric acid fuel cell technology, the most matured fuel cell technology, is predominantly suited for stationary, utility applications. However, this technology operates with the low temperature (400° F.), and thus is not suitable for cogeneration purposes. However, the high temperature advanced concept fuel cells (approximately 1,200° to 2,000° F.) may have potential for application in cogeneration. However, the industrial application of high temperature fuel cells and mobile applications will not be realized until the 1990's. Therefore there may also be technical reasons to undertake further review before amending PURPA to include fuel cell technology.

The Committee realizes that a major market for fuel cells lies outside the electric utility industry; however, the Committee believes any change to PURPA should only be considered in the context of a review of the total PURPA program.

Section 3 of the bill would direct the Secretary of Commerce to include fuel cell technology in the evaluation of renewable energy technologies under section 256 of the Energy Policy and Conservation Act.

Although the date of submission of the report has passed, the Department of Commerce has not completed the report. It is, therefore, feasible to include fuel cells in the evaluation.

Section-by-Section Analysis

Section 3 amends section 256 of the Energy Policy and Conservation Act to include fuel cell technology under the term "domestic renewable energy industry" for the purpose of obtaining an assessment of its potential in international export markets. The assessment from the International Trade Administration of the Commerce Department is to include an identification of export barriers, if any, and evidence of action on a program to coordinate and strengthen existing sources of Federal assistance available to promote renewable exports.

Section 4 charges the Environmental Protection Agency with the preparation of Federal guidelines for the benefit of cities and municipalities in specifying environmental and safety standards for use of fuel cell technology. Such guidelines are to be based in part on the successful experience of the New York City Fire Department in regulating the use of fuel cell technologies. The guidelines must be issued within 180 days after the date of enactment of this Act.

Section 5 requires the Secretary of Commerce to make an assessment and report to Congress within 18 days after the date of enactment regarding the export potential for integrated systems of fuel cells with renewable power technologies.

Cost and Budgetary Considerations

The following estimate of the cost of this measure has been provided by the Congressional Budget Office:

U.S. Congress,
Congressional Budget Office,
Washington, DC, September 29, 1986.

Hon. James A. McClure,
Chairman, Committee on Energy and Natural Resources, U.S. Senate, Dirksen Senate Office Building, Washington, DC.

Dear Mr. Chairman: The Congressional Budget Office has reviewed S. 1687, the Fuel Cells Energy Utilization Act, as ordered by the Senate Committee on Energy and Natural Resources, September 24, 1986. The bill amends the Energy Policy and Conservation Act to include fuel cells as a "domestic renewable energy industry" for the purposes of creating new international markets for domestic technologies. Under this bill, fuel cells will be included in the Department of Commerce's program for enhancing commerce in re-

newable energy technologies. The bill requires the Secretary of Commerce to assess and report to the Congress concerning the export market potential for integrated systems of fuel cells with renewable power technologies. In addition, S. 1687 directs the Environmental Protection Agency (EPA) to prepare environmental and safety guidelines for the use of fuel cells.

Based on information provided by the Department of Commerce and EPA, CBO estimates that preparation of the studies, reports and guidelines required by S. 1687 will cost about $1 million in fiscal year 1987. The bill will not result in any significant federal costs after 1987.

No costs will be incurred by state or local governments as a result of enactment of this bill.

If you wish further details on this estimate, we will be pleased to provide them.

With best wishes,

Sincerely,

EDWARD GRAMLICH
(For Rudolph G. Penner, Director).

REGULATORY IMPACT EVALUATION

In compliance with paragraph 11(b) of Rule XXVI of the Standing Rule of the Senate, the Committee makes the following evaluation of the regulatory impact which would be incurred in carrying out S. 1687 as reported.

Sections 3 and 5 of the bill would require the Secretary of Commerce to report to the Congress with an assessment of potential for export and identification of any export barriers. Since the Department of Commerce is conducting an evaluation of domestic renewable energy and related service industries, the inclusion of fuel cells would result in a minimal increase in administrative costs to the Department.

Section 4 of the bill would increase regulatory authority under EPA to set environmental and safety standards on fuel cells. So far, the development of fuel cell technology has placed major emphasis on the technical and economical factors. Any new EPA environmental regulation and safety standards could have a strong impact on the direction of future developments.

No personal information would be collected in administering the program, and there would be no impact on personal privacy from S. 1687.

EXECUTIVE COMMUNICATIONS

There were no legislative reports or communications received by the Energy and Natural Resources Committee from the Administration relating to S. 1687.

Following is the testimony submitted by the Administration at the February 24, 1986, Committee hearing:

Joint Statement Of

Robert L. San Martin
Deputy Assistant Secretary
for Renewable Energy,
Office of Conservation and
Renewable Energy

and

Richard E. Harrington
Deputy Assistant Secretary
for Coal Utilization, Advanced,
Conversion, and Gasification
Office of Fossil Energy

U.S. Department of Energy

to the

Committee on Energy and Natural Resources
Subcommittee on Energy Research and Development
U.S. Senate

February 24, 1986

Mr. Chairman and Members of the Committee:

Thank you for the opportunity to appear before you today to discuss the Department of Energy's fuel cell technology program and the two Senate bills relating to fuel cells, namely S. 1686 and S. 1687. Two organizational components of the Department of Energy are represented here today -- the Renewable Energy office and the Fossil Energy office. Both have ongoing, complementary research programs to develop fuel cell technology.

OVERVIEW

The DOE fuel cell program can trace its origins to work that began more than two decades ago in laboratory and special application research. Today this effort has evolved into a multi-faceted research program. The Office of Fossil Energy currently oversees research on Phosphoric Acid, Molten Carbonate, and Solid Oxide fuel cells. These are predominantly suited for stationary, utility, and large customer-side-of-the-meter application. The Renewable Energy group manages research on Solid Polymer Electrolyte fuel cells -- also known as Proton Exchange Membrane (PEM) fuel cells. The future application for this technology will be predominantly for mobile vehicle application.

This multi-pronged research effort is well coordinated, with both elements of the Department exchanging results and future plans on a regular basis.

Technology Description

Fuel cells are energy conversion devices that convert chemical energy directly into electrical energy without the inherent efficiency limits of heat engine cycles. A complete fuel cell power plant would typically include a fuel processing section (such as a reformer or a coal gasifier section with gas cleanup), the power producing section (often referred to as the fuel cell stack), and a power processing section with a direct current-to-alternating current inverter.

Fuel cells are powered by the electrochemical combination of hydrogen and oxygen. The source of hydrogen can vary considerably; virtually any hydrocarbon fuel can be a potential feedstock for a fuel cell power plant although for economic reasons, natural gas (methane) and coal will likely be the principal fuels. With low temperature (400 degree F) phosphoric acid fuel cells, the fuel must be processed in a reformer to produce a hydrogen-rich gas for the cell stack. Provisions are necessary to remove the odorants (sulfur compounds) which are mixed with the methane in natural gas to provide warnings of gas leakage. These sulfur compounds and other contaminants can degrade fuel cell and reformer performance unless reduced to low levels.

Other hydrocarbon fuels such as alcohols and petroleum distillates can be used in a similar manner as long as the reformer and fuel cell are protected from too high a level of contaminants.

More advanced fuel cell concepts -- specifically, the molten carbonate and solid oxide fuels cells -- offer the potential of streamlining the reforming process. The high cell operating temperature (approximately 1200 degrees F for molten carbonate fuel cells and approximately 1800 degrees F for solid oxide cells) has the potential to reform the natural gas directly within the fuel cell. Again, control of contaminants is required.

Higher operating temperatures may provide significant efficiency and capital cost advantages, however, elevated temperatures are not suitable for all potential fuel cell applications. In particular, the choice of a fuel cell for some mobile application may be dictated, in large part, by the need for a system capable of operating at reduced temperatures, i.e., the phosphoric acid or proton-exchange-membrane technology. Other concepts in the very early development phases (such as the monolith solid-oxide concept) may offer low weight and low volume systems compatible with some mobile applications.

Application of the Technology

The phosphoric acid fuel cell technology has been well proven but remains to be adopted commercially. The obstacles confronting phosphoric acid fuel cell applications are primarily economic in nature. The capital cost of the fuel cells is currently several times greater than alternatives such as gas turbines or conventional pulverized coal fueled steam generators. While mass production may make phosphoric acid fuel cells more competitive, industry must be prepared to address production and marketing issues before the technology will see widespread commercial application. It is possible that fuel cell technology will be applied initially in specific market niches and subsequently, evolve naturally into broader commercial use.

Fuel cell powerplants are expected to see their earliest applications in the electric utility power generation sector. Initial entry would be by plants using natural gas or distillate fuels and providing primarily peaking power or cycling power generation. Fuel cell plants operating on coal are expected to expand the potential market to baseload power generation applications.

A second area of fuel cell application is the residential and commercial sector. Strong interest by the gas utilities is evidenced by the ongoing field test of nearly fifty 40-kilowatt power plants producing electricity and cogenerated heat. Introduction of commercial gas-using fuel cells in this sector is also expected in the late 1980s. Due to the smaller size of fuel cell power plants in the residential and commercial sectors, direct integration of a fuel cell with a feedstock supplier (e.g., a coal gasifier) seems unlikely. Use of feedstocks such as coal or biomass in these applications will likely depend upon the economic competitiveness of processes to convert these fuels into pumpable gaseous or liquid products and the existance of suitable delivery systems.

Fuel cell use in the industrial sector could follow introduction in the electric utility sector and basically rely on modules similar to those being developed for electric utility plants. Fuel cell use in the transportation sector will depend upon the success of ongoing research efforts to overcome constraints on cost, size, and operating conditions.

Involvement with Domestic/International Groups

In addition to coordination among the two major fuel cell programs within the Energy Department, we participate in the National Fuel Cell Coordinating Group. Other members of this national program are the Electric Power Research Institute (with an electric utility interest), the Gas Research Institute (representing the gas utility industry), the National Aeronautics and Space Administration, the Department of Defense, and numerous private corporations involved in the development of fuel cells.

International interest and involvement is also helping to shape the future of fuel cells. Recently, for example, the International Fuel Cell (IFC) Corporation, jointly owned by United Technology Corporation and Toshiba of Japan, has been formed.

The Refocused Federal Program

In recent years, research interest within the Department has begun to shift from technology that is nearing commercial applications -- that is, the Phosphoric Acid fuel cell -- to more efficient, but less developed technologies, such as the Molten Carbonate, Solid Oxide and Solid Polymer Electrolyte. This is consistent with the Administration's policy of targeting taxpayer dollars toward those research efforts which remain beyond the scope of private research and development. An investment of more than $200 million by the Energy Department and more than $360 million by the private sector has brought the Phosphoric Acid technology to a sufficient maturity level such that the private sector can now assume full responsibility, as IFC has begun to, for the remaining development and commercialization of this technology.

In attachments to this testimony, we have provided more detailed descriptions of the ongoing fuel cell efforts within the Energy Department. These sections of our statement provide more definitive explanations of the cost-benefits of the fuel cell program, the practical and potential applications of fuel cells, and their commercialization potential.

Suffice it to say in this overview that fuel cell technology may be a promising energy supplier with attractive energy conversion efficiencies and environmental potential, provided the economic barriers that now exist can be overcome. Currently available fuel cells use hydrogen as a fuel which can be derived from a number of hydrocarbon sources. As a result, fuel cells are fuel flexible; they have been demonstrated to be capable of operating on methane gas generated from a variety of sources. The multifuel capability is one of the inherent advantages of fuel cells. Therefore, rather than demonstrating multiple sources of clean fuels, DOE has focused its program on cell and stack development and on developing improved methods for cleaning fuels that are inherently "dirtier" than natural gas to make them acceptable candidates for fuel cell applications. Once alternative fuels (e.g., fuels other than pipeline gas) have been cleaned, switching fuels is a relatively low risk commercial decision.

The technology is in hand to power a fuel cell using properly cleaned coal gas, landfill gas, methanol, natural gas and hydrogen. The use of fuels from biomass does not represent a major technical obstacle, but is more dependent upon competitive economics, the local fuel supply infrastructure, and uncertainties regarding capital costs and long-term durability.

S. 1686 & S.1687

Let me turn now to specific comments on the two Senate bills:

As indicated in both the overview and in subsequent program descriptions, substantial progress has been made in bringing fuel cell technology to its present state. The Phosphoric Acid technology, in particular, now stands ready for the private sector to commercialize -- its technical potential has been proven both for utility and smaller-scale, "onsite" applications.

ATTACHMENT 1

THE FOSSIL ENERGY FUEL CELL PROGRAM

The Office of Fossil Energy has a fuel cell systems program with the following goals:

- o Develop systems using natural gas and distillate fuels as an interim step toward developing coal-based fuel cell power plants;
- o In the long-term, develop advanced systems that use coal as a primary energy form.

The Fossil Energy program is participating with the private sector in developing fuel cell power plant technologies for electric utility, industrial and "on-site" applications that produce electric and thermal energy at the user's location.

In addition to these development activities, assessments are being performed to identify potential applications of fuel cells to new markets.

Currently, the Fossil Energy program is supporting the development of three types of fuel cells (characterized by the cell electrolyte used): phosphoric acid, molten carbonate, and solid oxide. The federal role is principally to support the development of fuel cell stack technology; the private sector is developing the balance of plant subsystems and will undertake future market-related activities.

The Fossil Energy fuel cell program is currently directed towards multi-megawatt electric utility power plants and multi-kilowatt on-site power plants for commercial and industrial applications. In some uses, first generation phosphoric acid systems offer attractive benefits, however, more advanced fuel cell technologies -- the molten carbonate and solid oxide systems -- are expected to offer additional benefits in terms of economics, technical performance and fuel flexibility. Compared to phosphoric acid systems, the advanced fuel cell technologies are expected to be more amenable

In light of the technical maturity achieved by today's first-generation fuel cells, we must conclude that neither S. 1686 nor S. 1687 is required to meet the objectives of stimulating fuel cell research and applications. Particularly in a time of tight budgets, we believe taxpayer dollars are more appropriately spent on longer-range, more generic research that will benefit all types of fuel cells, rather than on perfecting technologies that are within the commercial scope of the private sector.

We have much the same reaction to the specific cogeneration provisions of S. 1687. While recognizing that the ultimate objectives of the bill are sound, we question whether it is necessary to accomplish its stated goal. The phosphoric acid fuel cell has been demonstrated at several sites across the country to be capable of generating both onsite electric power as well as usable thermal energy. The molten carbonate and solid oxide fuel cells, still currently in less mature stages of development, may be substantially better candidates for cogeneration application since they operate at much higher temperatures.

Clearly, where government can provide the most effective contribution to fuel cell technology is in building a solid base of technological information which industry can use to make market-oriented, developmental decisions.

Our current fuel cell program, particularly as it is presented within the President's Fiscal Year 1987 budget request, has been carefully fashioned to ensure that tax dollars are not supplanting private sector funding. We will continue to make available to the private sector the results of our technology-base research and we will encourage them to implement this research when market forces dictate.

The Department of Energy is committed to expanding the range of technical options available to the private sector that will improve our Nation's energy future; fuel cells are a sound prospect for this future. As I indicated previously, the remaining pages of our testimony provide more details on the ongoing fuel cell efforts within the Department of Energy.

Thank you for the opportunity to discuss this area of research with you today.

to integration with a coal gasifier. The rationale for development of multiple advanced technologies is that, at the present embryonic state of development of these advanced concepts, it is uncertain which technology will be able to progress satisfactorily to the point of a commercial prototype power plant, the development stage already achieved by phosphoric acid systems.

Phosphoric Acid Fuel Cells

Phosphoric acid systems are the most mature of the fuel cell systems under development by DOE and have the greatest private sector cost-sharing. Phosphoric acid systems have been under development since the 1950s by the private sector, and since 1976, by DOE (formerly ERDA). Over that period of time, DOE has expended $200M and the private sector over $360M, for research on phosphoric acid fuel cells. There has been a strong and continuing interest in phosphoric acid systems (and advanced systems) by the electric and gas utilities.

Within the phosphoric acid program, two fuel cell applications are being pursued -- electric utility systems and on-site integrated energy systems. The primary difference between the two applications is fuel cell unit size, with the electric utility systems being in the multi-MW range and the on-site systems in the 40 kW to 400 kW range. Parallel design approaches are being pursued in each of these areas. The phosphoric acid fuel cells being developed in one effort use a water cooling loop for cooling of the fuel cell section. This is the technology used in a 4.8 MW preprototype electric utility power plant designed to operate on natural gas or petroleum distillate in a joint project with EPRI and Consolidated Edison. This technology was also used in a year long field test of forty-six 40 kW on-site/integrated energy systems in a joint project with the Gas Research Institute involving test sites in 22 states and participation of nearly 40 utilities.

As of January 1986, the 40 kW field test program has logged a cumulative total of over 266,000 hours of operation. Although many of the units have completed testing, 26 powerplants were still being tested as of the end of 1985. Among the units still being tested are two powerplants that are already using alternate fuels. Southern California Edison is operating one of these fuel cell powerplants on landfill gas using a modified off-the-shelf gas cleanup system. Southern Company Services operates their unit on coal bed methane in Muscle Shoals, Alabama. The Southern California Edison unit has accumulated over 4400 hours and the Southern Company Services powerplant has operated over 7500 hours of the total 8000 hours planned for each unit in the field test program. Both powerplants have the capability of switching from pipeline natural gas to the alternate fuel with no degradation of performance observed.

This field test is presently being completed under the management of GRI. Further advancement of cell and stack technology is expected to lower plant costs and improve the performance of plant subsystems. Such advancements are currently being developed and evaluated for incorporation into an 11 MW electric utility power plant design and into a 200 kW on-site system.

An alternative phosphoric acid systems approach for electric utility power plants uses gas-loop cooling of the fuel cell section. Performance goals have been demonstrated in 9 and 10 cell, gas-cooled stacks for two to three thousand hours (goal is 40,000 hours) and scaleup to 25 and 100 kW stacks has been started. The developer, Westinghouse, is designing a 7.5 MW system which would utilize multiples of the 100 kW stacks.

An alternate phosphoric acid system is also under development for on-site cogeneration application. This system uses a dielectric fluid for stack cooling. A 25 kW stack has been tested and a second is being made

ready for tests. The developer, Engelhard, plans to use multiples of these 25 kW stacks in on-site systems of 25 to 100 kW.

Private sector commercialization of first generation technology (i.e., phosphoric acid system) is expected to aid in establishing a viable fuel cell industry that can assume responsibility for developing improved fuel cell types in the course of typical product improvement.

Molten Carbonate Fuel Cells

Molten carbonate fuel cell technology is at an earlier stage of development than the phosphoric acid fuel cell. The molten carbonate fuel cell program was initiated in 1976. A series of exploratory development projects focused on verifying feasibility and identifying technology development needs. This resulted in a major effort beginning in 1979 to develop the technology to permit large scale molten carbonate systems to operate on coal.

Cell performance goals have been demonstrated in short term tests with clean gas. A two thousand hour test of a subscale stack (20 cell, 1 square foot each) has demonstrated adequate solution of the electrolyte management problem which had been present in earlier molten carbonate stacks. Current efforts focus on improving the life of cell components within cost constraints and on scaling-up to full size stack components.

The concept to improve performance through internal fuel reforming of natural gas or other sources of methane is also being developed. This concept has been demonstrated in cells and a small stack but has not yet been incorporated into large stacks or tested for long duration.

Solid Oxide Fuel Cells

Solid oxide fuel cell technology is in the earliest stages of development. These fuel cells operate at high temperature (approximately 1800°F), thereby

offering high-quality co-product heat for cogeneration or for use in a bottoming cycle for increased efficiency. In addition, they offer the potential for using simple fuel processing systems because carbon monoxide in the fuel gas does not have to be converted with steam to hydrogen and carbon dioxide (as in phosphoric acid systems), and CO_2 recycle is not required (as in the molten carbonate systems). Internal reforming is readily achieved as a result of the high operating temperature, and solid oxide cells have a lower sensitivity to sulfur impurities.

The current DOE effort, initiated in 1980, is aimed at producing a practical cell design and fabricating and testing a 5 kW generator in 1986, operating on coal gas. Submodules which would form parts of the 5 kW generator have been tested for several thousand hours and substantial progress has been made in fabricating these cells and submodules. Upon successfully testing the 5 kW generator, it is planned to design and test a 100 kW module to verify the technical feasibility of the solid oxide fuel cell for utility power generation from coal gas.

ATTACHMENT 2

RENEWABLE ENERGY RESEARCH

1. Background

With funding from the Office of Energy Storage and Distribution (OESD), the Electronics Division at Los Alamos National Laboratory is conducting an integrated research and exploratory development program on proton exchange membrane (PEM) fuel cells for small vehicle applications. The objective is to take this fuel cell technology from its present status as a laboratory device to a proof-of-concept level, establishing a practical alternative to internal combustion engines (ICE) for vehicular propulsion. The research is aimed at developing technology with range and performance equivalent to an ICE, high efficiency, ability to use a nonpetroleum fuel (methanol), and low air and noise pollution. A system study, carried out at Los Alamos National Laboratory, indicates that a fuel-cell-powered vehicle using methanol can travel approximately twice as many miles as an ICE using gasoline. The by-products of a methanol-powered fuel cell are almost entirely water and carbon dioxide which would make fuel cell propulsion particularly attractive for urban applications.

To realize the potential of transportation fuel cells, the power density must be increased from 2.8 kW/meter^2 to 7.0 kW/meter^2, the cost must be reduced from \$300/kW to \$50/kW, and the transient performance and startup characteristics of the system must be improved from 7 to 10 minutes to a minute or less. The key areas under investigation in the DOE/

OESD effort are, therefore: (1) developing an understanding of electrocatalysis and of new, improved electrocatalysts; (2) developing an understanding of ion and water molecule transport in membranes and use of this understanding to design an improved and cheaper membrane; and (3) an understanding of the catalytic conversion of methanol to hydrogen and carbon dioxide (reforming) in order to design and fabricate a fuel processor capable of meeting the necessary transient behavior for vehicular applications.

In support of these key areas, single cell testing of PEM fuel cells to determine performance, operational parameters, and possible unique failure modes under vehicular operational regimes is being carried out. In addition, a 20-kW state-of-the-art methanol reformer/phosphoric acid fuel cell has been tested to provide baseline performance data.

At a workshop held at Los Alamos in August 1977, at which automotive companies and fuel cell research and development companies were represented, methanol was selected as the fuel of choice for fuel-cell-powered vehicles. As a liquid fuel, methanol would enable much of the existing industrial plant and distribution system to be maintained. Moreover, methanol can be synthesized from natural gas, coal, biomass, and other sources. For a fuel cell, methanol is a means of storing hydrogen at high density. A process called reforming, by which hydrogen is produced, is therefore an important facet of the research. Of all the hydrocarbon-based fuels, methanol is reformed at the lowest temperature, 200-250°C. Carbon dioxide, a by-product of reforming, is compatible with fuel cells based upon acid electrolytes, because carbonates are precipitated in aqueous alkaline electrolytes and blocks gas transport within the cell.

Low temperature fuel cells operating on reformed methanol are, therefore, restricted to acid electrolytes.

A second factor that determines the choice of fuel cell for mobile application is operating temperature. In such a system with frequent cycling, the lower the operating temperature, the better. In our view, this restricts the choice to phosphoric acid and PEM fuel cells. The phosphoric acid fuel cell, which operates at 200°C, is the most highly developed at the present time, while the PEM cell operates below 100°C. Since there is no need for high quality cogenerated heat in a vehicle, the low temperature is not a penalty as it would be in stationery applications.

By the end of FY 1984, Los Alamos was focused on the PEM fuel cell system due to its advantages of lower operating temperature and higher power density.

The major thrust areas; electrocatalysis, PEM structure and transport, and reformer chemistry will now be described:

Electrocatalysis

In a fuel cell, the activity and cost of the catalysts are dominant factors in the design. Even small improvements in the activity of the cathode catalyst (tens of milivolts increase in cell voltage) can result in significant improvements in efficiency and major improvements in power density, both of which are very important for vehicular applications.

Accordingly, a substantial part of the current research at Los Alamos addresses the catalyst problem. This work ranges from fundamental theoretical and experimental studies to the characteristics of, and life tests of promising catalysts.

Membrane Structure, Transport, and Interface Studies

PEM fuel cells are based on a fluorocarbon polymer membrane that exhibits facile proton conduction. Most current cells are based on a commercial polymer which consists of long teflon-like polymer chains with sulfonic acid side groups. To conduct protons, the membrane must contain significant amounts of water. Improved fuel cell design will require optimizing the ion transport, managing the water transport, improving the electrode contact, and reducing the cost of these membranes.

The effort to understand both ion and water transport phenomena is being attacked by both experimental and modeling efforts. A working model for the membrane structure has been developed. It is speculated that the polymer molecule takes on a helical configuration allowing an interaction between the sulfonic acid side groups to form water-filled ionic clusters. Such clusters are inferred from x-ray data and are a critical element in most models of ion transport through the membrane. Using this configuration as a basis, both continuum and molecular dynamic calculations of transport through the membrane have been conducted.

Understanding the factors affecting water flow through PEMs is critical for modeling and designing membranes and maintaining water balance

in operating fuel cells. Data were determined for water flow through membrane samples. Results showed that flow rates depend directly on the hydrated ion size. This offers confirmation of the hypothesis that the transport channels result from the competition between ionic repulsion forces and the stress from the polymer backbone.

A critical factor determining PEM fuel cell performance is the electrode catalyst-membrane interface where the chemical reactions take place. Complex impedance spectroscopy is being used to determine the steps in the reactions. Measurements of carbon monoxide poisoning on smooth platinum hydrogen electrodes were also made with this technique. It was also observed that carbon monoxide poisoning persisted even 15 hours after flushing with pure hydrogen. On conventional PEM electrodes, 1% carbon monoxide reduced the current density at room temperature by about two orders of magnitude.

Perhaps the most significant achievement this year was the demonstration that the catalyst loading in a PEM fuel cell can be dramatically reduced by pretreating commercially available (Prototech) electrodes with the polymer. The electrodes were painted with a thin layer of a solution of the polymer and then air dried. Although these electrodes contain about an order of magnitude less platinum than the conventional PEM electrodes, at moderate temperatures their performance is comparable for both anode and cathode reactions. This is an important advance since the cost of platinum has been the major cost in PEM fuel cells. Further work on these electrodes will be focused on higher temperature operation where

control of the hydration of the membrane in both the electrolyte and the electrode structure is more difficult.

Evaluation is continuing of commercially available membranes that retain performance levels while offering a cost reduction from the membrane now used. This approach is combined with the catalyst loading reduction mentioned earlier. To date a membrane has been identified with acceptable performance at about half the cost of the presently used membrane.

Reformer Investigations

Results to date have shown that the reformer is one of the most critical components in attaining a viable vehicular power plant. The methanol reformer must be able to meet transit requirements and still maintain minimum carbon monoxide levels. Present designs are not capable of doing this. A thorough understanding of the reforming reaction is necessary to attain satisfactory reaction rates at adequate space velocities with minimal or no carbon monoxide production. Heat and mass transfer within the reformer system also must be well understood. Efforts are pursuing both experimental and modeling approaches to gain an understanding of reforming and to reach a point where a reformer can be designed and fabricated that can meet the transient and fuel quality requirements.

Future Research and Development Plan

The research of the past several years has increased our confidence that PEM-based fuel cells are the most promising technology for widespread use in the transportation sector. They offer the potential for higher power density, better startup characteristic, higher reliability, and lower cost than other fuel cell types that can operate with methanol-derived fuel in a vehicular application. A high power density, low cost PEM technology will also find many other applications particularly where compact or mobile electric power is required. Many of these virtues derive from the lower operating temperature of PEM fuel cells. Low operating temperature facilitates startup, minimizes material corrosion, and allows cheaper plastic and extrudable components to be used. The solid electrolyte also simplifies the design and sealing of the cells. However, the high quality heat that is cogenerated by high temperature installations increases the efficiency in stationery applications.

Problems remain to be solved. These include increasing the power density to levels that can compete with internal combustion engines; reducing the fundamental costs of catalysts, membranes, and bipolar plates; improving the carbon monoxide tolerance of the anode catalyst while reducing the carbon monoxide content in the reformed fuel, and improving the transient performance of the fuel processor/fuel cell system. As mentioned before, the problem remains in water management, both in the electrode and in the PEM itself. The most recent results from improved membranes, alternative proton conductors in the electrodes, and cells designed to sustain the hydration of the components suggest

that this goal can be achieved. In parallel with this effort, work needs to continue in the areas of membrane transport and carbon monoxide tolerance. Advances in these areas then can be incorporated into the fuel cell design to provide higher power density and good performance on reformed methanol containing small amounts of carbon monoxide.

CHANGES IN EXISTING LAW

In compliance with paragraph 12 of Rule XXVI of the Standing Rules of the Senate, changes in existing law made by the bill, S. 1687, as ordered reported, are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new matter is printed in italic, existing law in which no change is proposed is shown in roman:

ENERGY POLICY AND CONSERVATION ACT

Public Law 94-163, as Amended

* * * * * * *

DOMESTIC RENEWABLE ENERGY INDUSTRY AND RELATED SERVICE INDUSTRIES

SEC. 256. (a) It is the purpose of this section to implement the responsibilities of the United States under chapter VII of the international energy program with respect to development of alternative energy by facilitating the overall abilities of the domestic renewable energy industry and related service industries to create new markets.

(b)(1) Before the later of—

(A) 6 months after the date of the enactment of this section, and

(B) May 31, 1985,

the Secretary of Commerce shall conduct an evaluation regarding the domestic renewable energy industry and related service industries and submit a report of his findings to the Congress.

(2) Such evaluation shall include—

(A) an assessment of the technical and commercial status of the domestic renewable energy industry and related service industries in domestic and foreign markets;

(B) an assessment of the Federal Government's activities affecting commerce in the domestic renewable energy industry and related service industries and in consolidating and coordinating such activities within the Federal Government; and

(C) an assessment of the aspects of the domestic renewable energy industry and related service industries in which improvements must be made to increase the international commercialization of such industry.

(c)(1) On the basis of the evaluation under subsection (b), the Secretary of Commerce shall, consistent with existing law, establish a program for enhancing commerce in renewable energy technologies and consolidating or coordinating existing activities for such purpose.

(2) Such program shall provide for—

(A) the broadening of the participation by the domestic renewable energy industry and relatd industries in such activities.

(B) the promotion of the domestic renewable energy industry and related service industries on a worldwide basis;

(C) the participation by the Federal Government and the domestic renewable energy industry and related service industries in international standard-setting activities; and

(D) the establishment of an information program under which—

(i) technical information about the domestic renewable energy industry and related service industries shall be provided to appropriate public and private officials engaged in commerce, and

(ii) marketing information about export opportunities shall be available to the domestic renewable energy industry and related service industries.

(3) Necessary funds required for carrying out such program shall be requested inconnection with fiscal years beginning after September 30, 1984.

(d) There shall be established an interagency working group which, in consultation with the representative industry groups and relevant agency heads, shall make recommendations to coordinate the actions and programs of the Federal Government affecting commerce in renewable energy products and related services. The Secretary of Energy shall be the chairman of such group. The heads of appropriate agencies may detail such personnel and may furnish such services to such working group, with or without reimbursement, as may be necessary to carry out its functions.

(e) For purposes of this section, the term "domestic renewable energy industry" shall include industries using fuel cell technology.

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